APPENDIX K

SANITARY SEWER SYSTEM ANALYSIS

PREPARED BY:
MARK THOMAS & COMPANY

SEPTEMBER 2006

East Sunnyvale ITR Project

Sanitary Sewer

This report provides a discussion of the existing sanitary sewer system relative to the East Sunnyvale ITR Project.

Project Location. The East Sunnyvale ITR project area is located in east Sunnyvale, generally bounded by Duane Avenue on the north, Stewart Avenue on the south, Wolfe Road / Fair Oaks Avenue on the west and Lawrence Expressway on the East. The Kings Academy High School, formerly Sunnyvale High School, and Fair Oaks Park are located on the west side of the project site. The nearest major thoroughfares are U.S. Highway 101, Bayshore Freeway, to the north, Central Expressway to the south, and Lawrence Expressway to the east.

Land Use. The project is currently zoned for industrial uses and is occupied by that type of use. The project plans to change the General Plan designation from Industrial to ITR, or Industrial-to Residential. The ITR designation allows for the continuation or expansion of existing industrial and commercial uses as well as the construction of new residential housing. Proposed residential conversion on this site includes R-3 medium density at 12 to 25 dwelling units per acre and R-4 high density residential development at 25 to 36 dwelling units per acre. Figure 1 shows the proposed Land Use Plan. It is anticipated that the site will be developed within the range of 1638 to 2842 units.

Existing System. The project site is served by the City of Sunnyvale municipal sewer system that collects the waste water from the existing industrial uses. The existing system consists of 10" to 18" pipes within the existing street right-of ways of Duane Avenue, Stewart Drive, North Wolfe Road, De Guigne Drive and East Duane Avenue. These pipelines connect to the 27" trunk line in Lawrence Expressway through an 18" pipeline in Duane Court and a 10" pipeline in East Duane Avenue.

Existing flows were monitored for 2 weeks from July 28, 2006 to August 11, 2006, at 8 sites, 3 of which were located upstream of the project site to measure the existing flows coming into the project area from the south. The existing flow data is presented in the report entitled Sanitary Sewer Flow Monitoring and Capacity Analysis, dated September 2006, prepared by V & A Consulting Engineers, a copy of which is attached. The locations where the existing flows were monitored are shown on Figure 1 in the Analysis.

Proposed Project. Proposed residential development on this site ranges from a high density (R-4) of 25 to 36 dwelling units per acre to medium density (R-3) of 12 to 25 units per acre. It is anticipated that the site will be developed within the range of 1638 to 2842 units.

Based on information received from the City of Sunnyvale, Department of Public Works we can assume an average of three (3) people per residential unit with a daily use of 75 gallons per day per person. This produces a flow of 225 gallons/unit/day for residential

use. The City would like to see if sufficient sewer capacity is available using a more conservative estimate based on 3.3 people per dwelling unit or a rate of 250 gallons/unit/day for residential use. The sewer system was evaluated using the more conservative value of 250 gallons/unit/day.

Sewage flows from sites vary over the 24 hour course of a day. Sewage flow from commercial and industrial establishments are generated during the operating hours. Sewage flows from residential areas are associated with activities in the homes with peak flows occurring generally from 7 to 10 A.M. and in the evening between 6 and 10 P.M., and sewers are designed to accommodate peak flows.[1] The footnoted text presents 2 equations for peak factors:

$$\text{Peak Factor} = 5/p^{0.2} \qquad (25.1)$$

$$\text{Peak Factor} = 1 + 14/4 + p^{0.5} \qquad (25.2)$$

Where p is the contributing population in thousands. Using the upper unit number of 2842 with 3.3 persons per unit produces an expected population of 9380. This figure applied to the above equations produces a Peak Factor of 3.2 and 3.0 respectfully.

The Sanitary Sewer Flow Monitoring and Capacity Analysis also presents the peak flow, low flow and average flow over the monitoring period at the 8 sites. The ratio between the peak flow to the average flow is presented in Table 1 of the Analysis. These Peak to Average Flow ratios vary from a low of 1.25 to 3.39. As expected, the lower peak ratios occur at the downstream locations where the measured flow is higher, and the higher ratios occur at the upstream locations having the lower measured flows. Considering the above, a peak factor of 3.5 was used to estimate the flows produced by the proposed project. The measured flows were increased by 5% due to the dry weather time in which they were measured and are included in the capacity calculations.

The development of all 2842 residential units multiplied by 250 gallons/unit/day produces 0.71 million gallons per day (Mgd) or 1.1 cubic feet per second (cfs). A peak flow factor of 3.5 produces a total flow of 2.49 Mgd or 3.85 cfs. These flows were distributed to the existing sewer system based on the sub-area's unit count and resulting expected flow. See Table 1 for flow per sub-area.

In addition to the residential flow a retail component was introduced from area 16. According to information provide by the City of Sunnyvale, Department of Public Works we can assume a flow of 120 gallons/day/1000 sq.ft. for commercial/light industrial mixed-use development and 70 gallons/day/1000 sq.ft. for strictly retail use. We have assumed that the retail area will have a maximum floor area ratio (FAR) of 50% and used the more conservative flow of 120 gallons/day /1000 sq.ft.

[1] Land Development Handbook, McGraw Hill, 2002

The retail area shown on Figure 1 occupies approximately 9.6 acres, or 417,600 sq. ft. Fifty percent of this area multiplied by 120 gallons per day divided by 1000 sq. ft. produces a demand of 0.025 Mgd or 0.388 cfs.

The existing sewer pipelines were evaluated for capacity by checking the total anticipated flow with the available capacity of the existing pipelines by virtue of their diameter and slope. The existing pipeline slopes were determined by field surveys. Calculations were based on Manning's formula using an 'n' factor of 0.13. The City Standard for sanitary sewer pipes to flow at a maximum of 75% of flow depth was used. See Figure 2 for calculated flows in existing pipeline segments.

Conclusions. Generally the calculations show that the existing sewers have the capacity to serve the proposed project with certain limitations. The 27" sewer in Lawrence Expressway has the capacity to carry the increased flows that the project will produce. The peak flows from the proposed project added to the peak measured flow in the 27" line in Lawrence Expressway fills the pipe to 56 % of its depth. It should be noted that these calculations do not include flows from the east that connect to this 27" line at or downstream of the project. The limitations include where and to what the proposed residential areas are to be connected.

The existing 10"sewer line in the easterly portion of Stewart Drive has the capacity to serve all of the 224 units in Area 6, but only 325 units of the 827 proposed units in Area 3. The remaining 502 units in Area 3 could be connected to the 8" line that flows to the northwest in East Duane Avenue and/or the existing 18" line in Duane Avenue. The existing 12" sewer line in De Guigne Drive has the capacity to serve all of the units from Areas 9, 10, 11, 12 and 13, but does not have the capacity to serve additional units from Areas 7, 8 and 14. Areas 7 and 8 should be connected to the northerly 15" line in Duane Avenue that currently serves the existing industrial uses that occupy this site. The 100 units in Area 14 should be connected to the existing 12" sewer line that runs along the westerly boundary of the project.

Additionally, the segment of the existing 15" sewer line that flows to the east in Duane Avenue from the connection point, or manhole, of the 12" line in De Guigne Drive would be impacted by the flow increase due to the proposed residential units. Due to the relatively flat slope of 0.0010 feet per foot of this segment it does not have the capacity to serve the increased flows generated by the proposed project. This impact could be mitigated by relocating the 12" sewer line in De Guigne Drive through Areas 4 and 5 and connecting to the existing 15" line flowing east in Duane Avenue at the existing manhole located 290 feet east of the manhole at the intersection of De Guigne Drive and Duane Avenue. This same 15" line has the capacity to serve the increased flows at this location due to the increased slope of 0.003 feet per foot. This impact could also be mitigated by taking the flow from the existing 12" line to the west of De Guigne Drive and connecting it to the existing 15" line that is northerly to and parallel to this 12" line.

ITR Study Area
Development Scenario Worksheet
Table 1

Alternative 1 = Proposed Project

AREA	ZONING	UNITS	Average Flow Gallons per Day (GPD)	Peak Flow Gallons per Day (GPD)
1	R-4	263	65750	230125
3A	R-3	325	105000	367500
3B	R-4	502	101750	356125
4&5	R-3	297	74250	259875
6	R-3	224	56000	196000
7	R-4	19	4750	16625
8	R-5	521	130250	455875
9	R-6	220	55000	192500
10	R-7	218	54500	190750
11	R-8	72	18000	63000
12	R-9	28	7000	24500
13	R-10	19	4750	16625
14	R-11	103	25750	90125
15	R-12	31	7750	27125
16	RETAIL		25013	87546

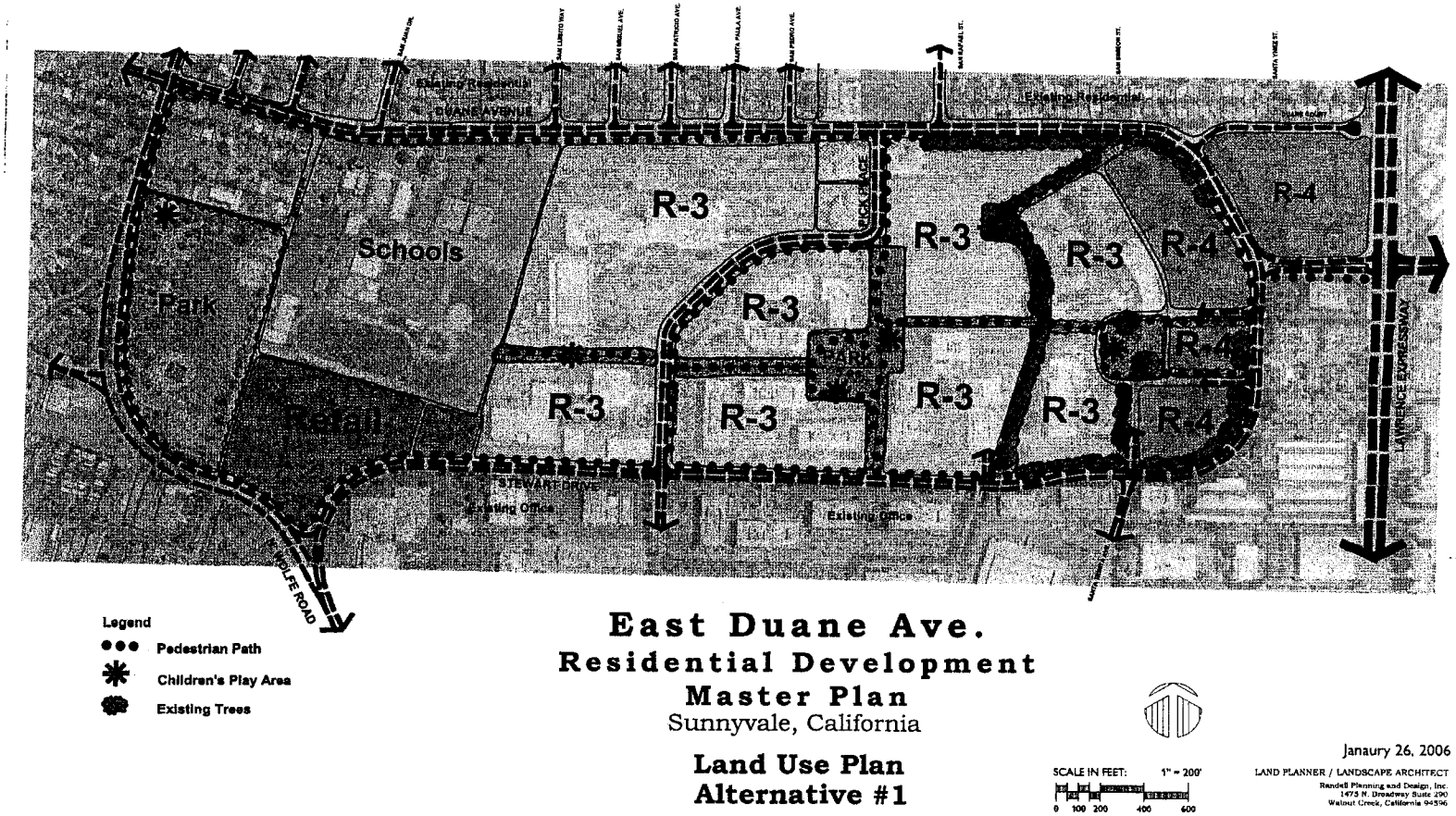


Figure 1: Proposed GPA Land Use Plan

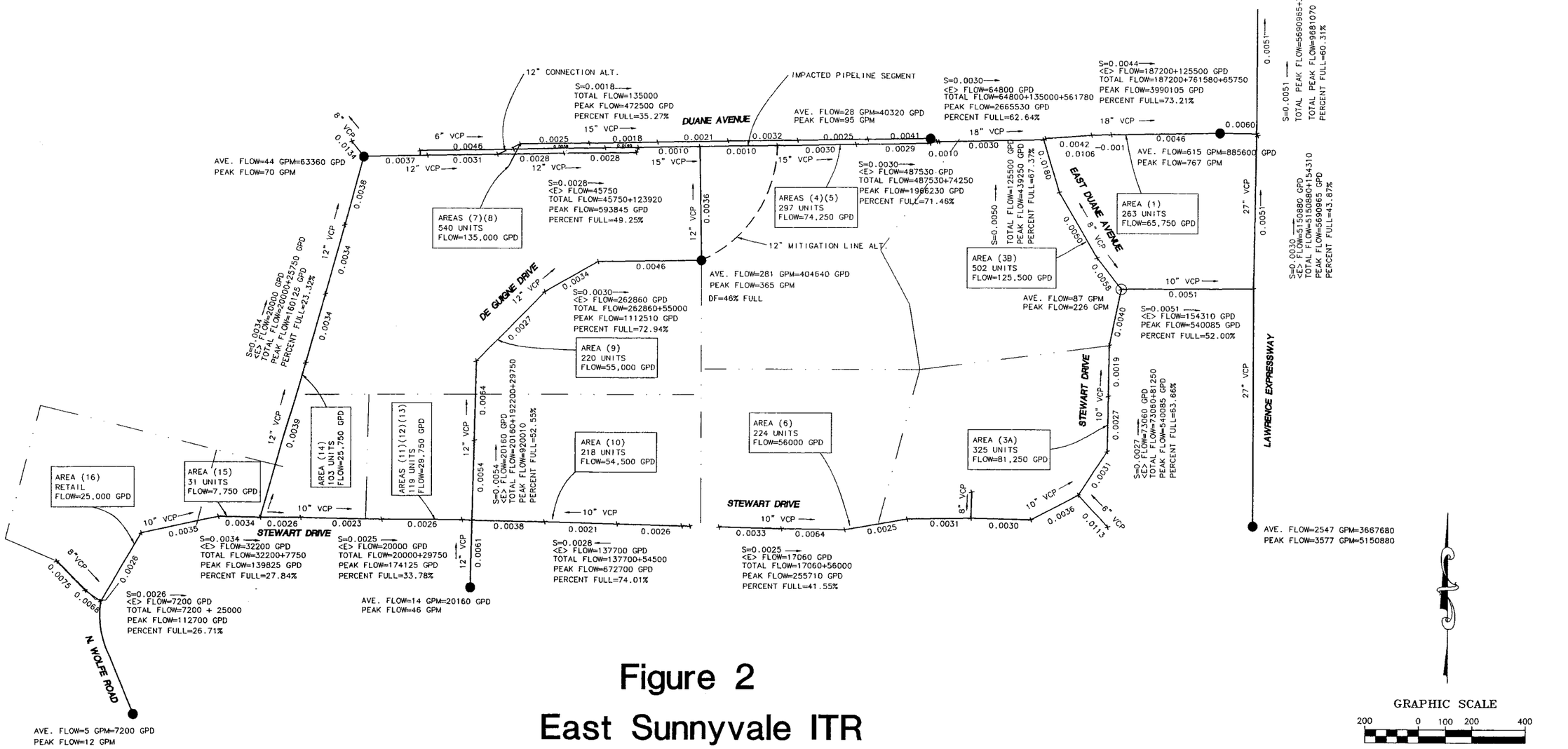


Figure 2
East Sunnyvale ITR
Existing Sewerline Layout

NOTE:

A PEAK FACTOR OF 3.5 WAS USED TO CALCULATE THE PEAK FLOWS.

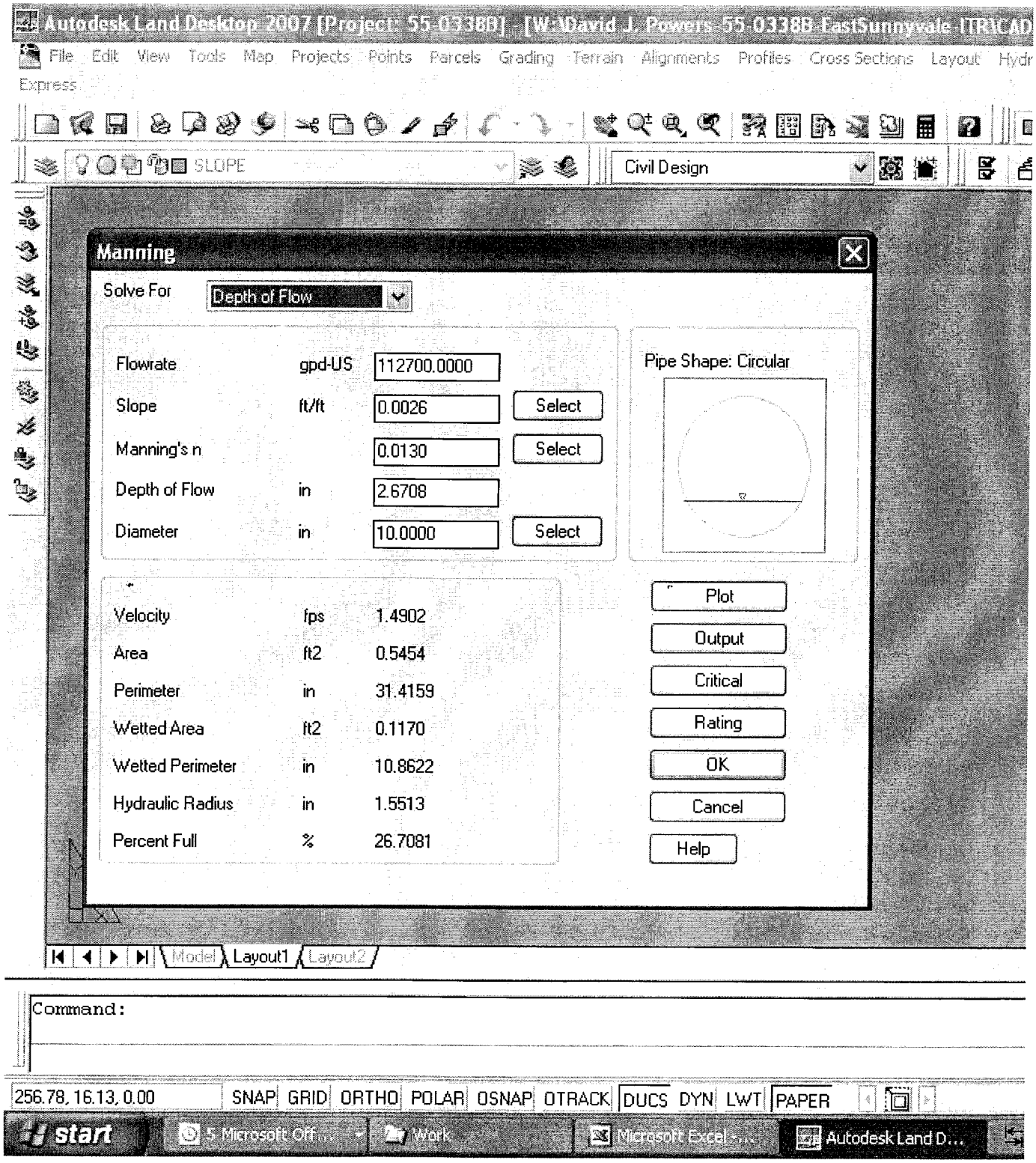
GRAPHIC SCALE

200 0 100 200 400

1" = 200'

MARK THOMAS & COMPANY, INC.
Providing Engineering, Surveying, and Planning Services
1960 Zanker Road
San Jose, CA 95112
(408) 453-5373

September 25, 2006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Wetted Area ft2 0.1170
Wetted Perimeter in 10.8622
Hydraulic Radius in 1.5513
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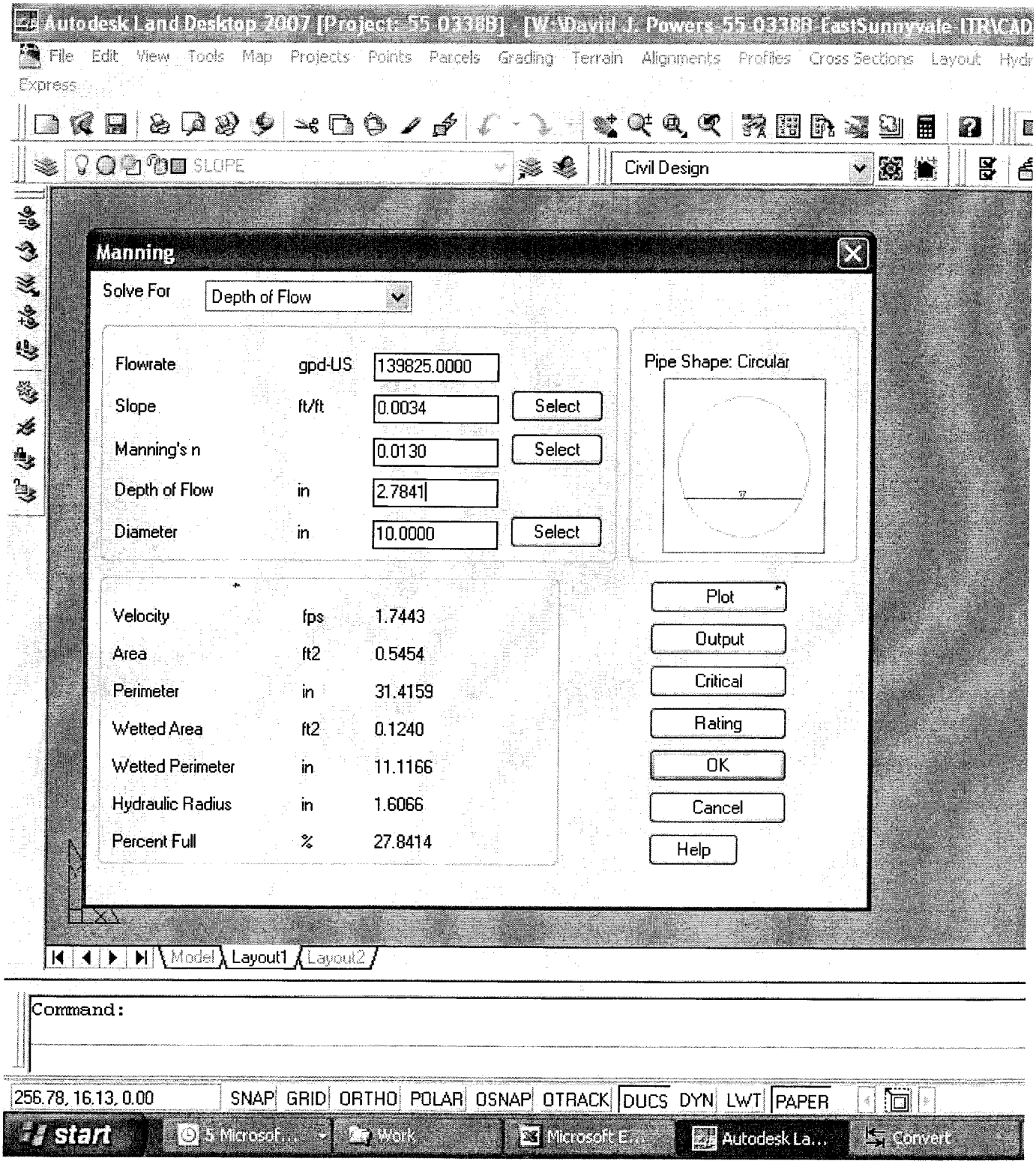
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Wetted Perimeter
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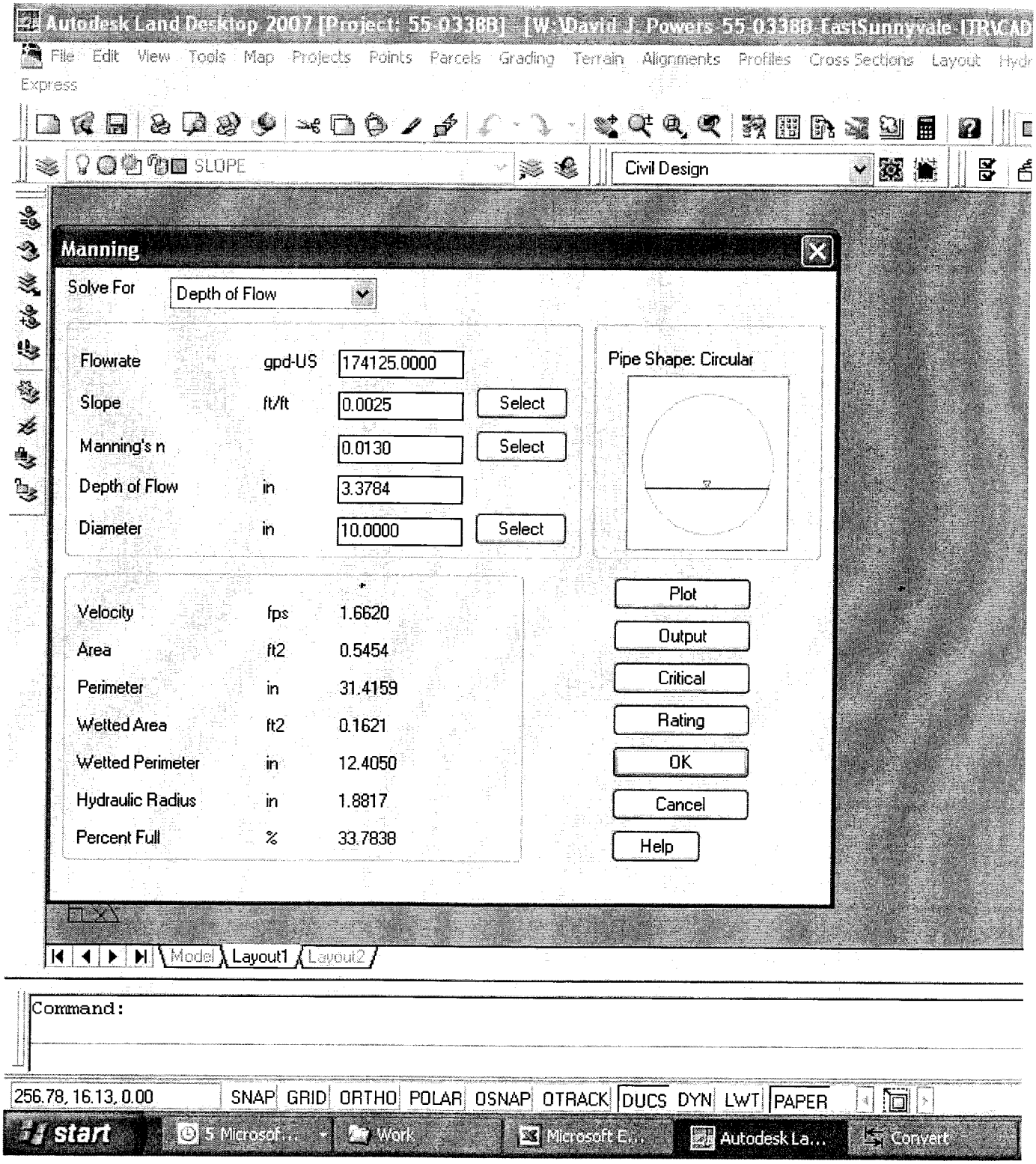
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Wetted Area ft2 0.1621
Wetted Perimeter in 12.4050
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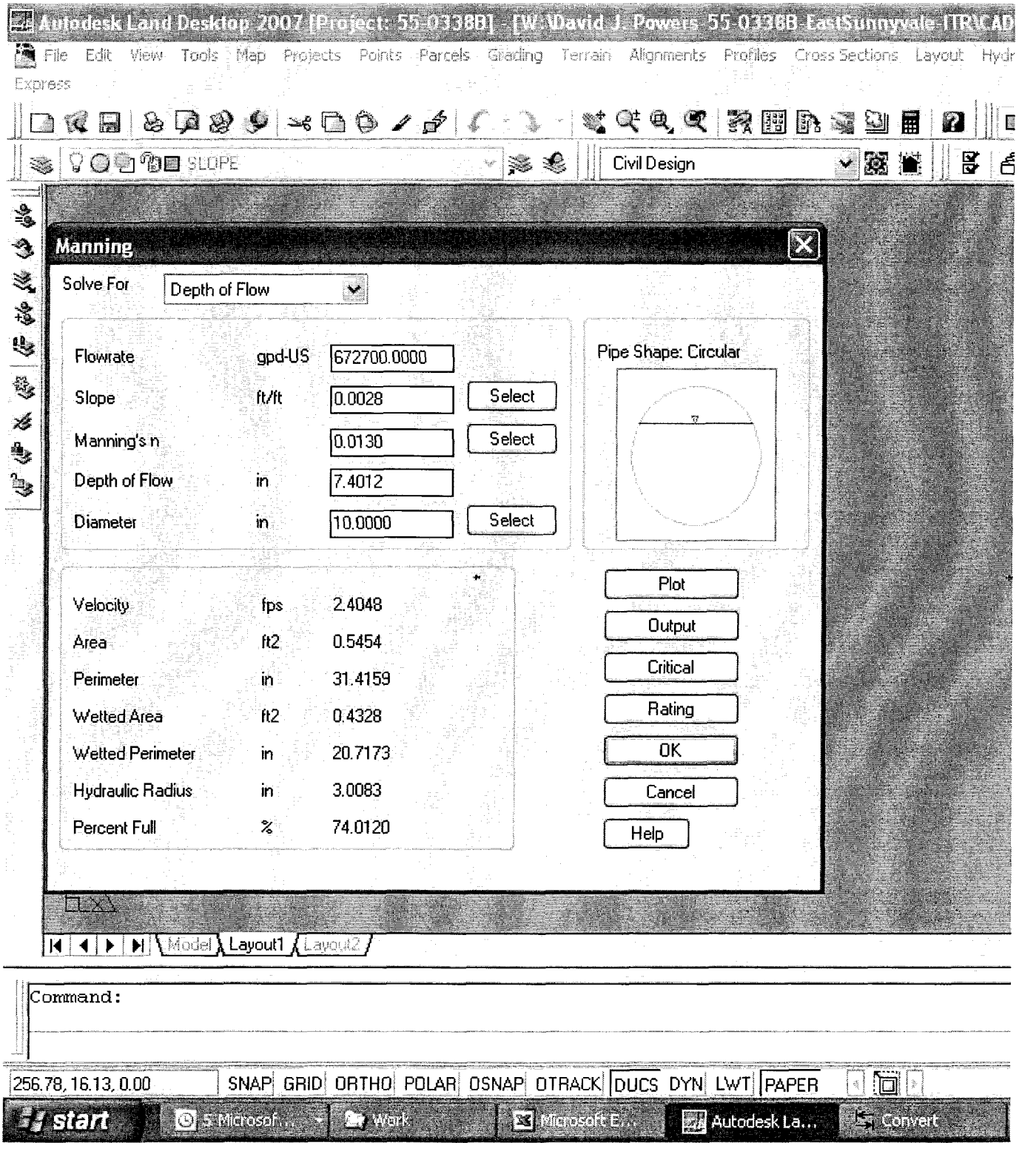
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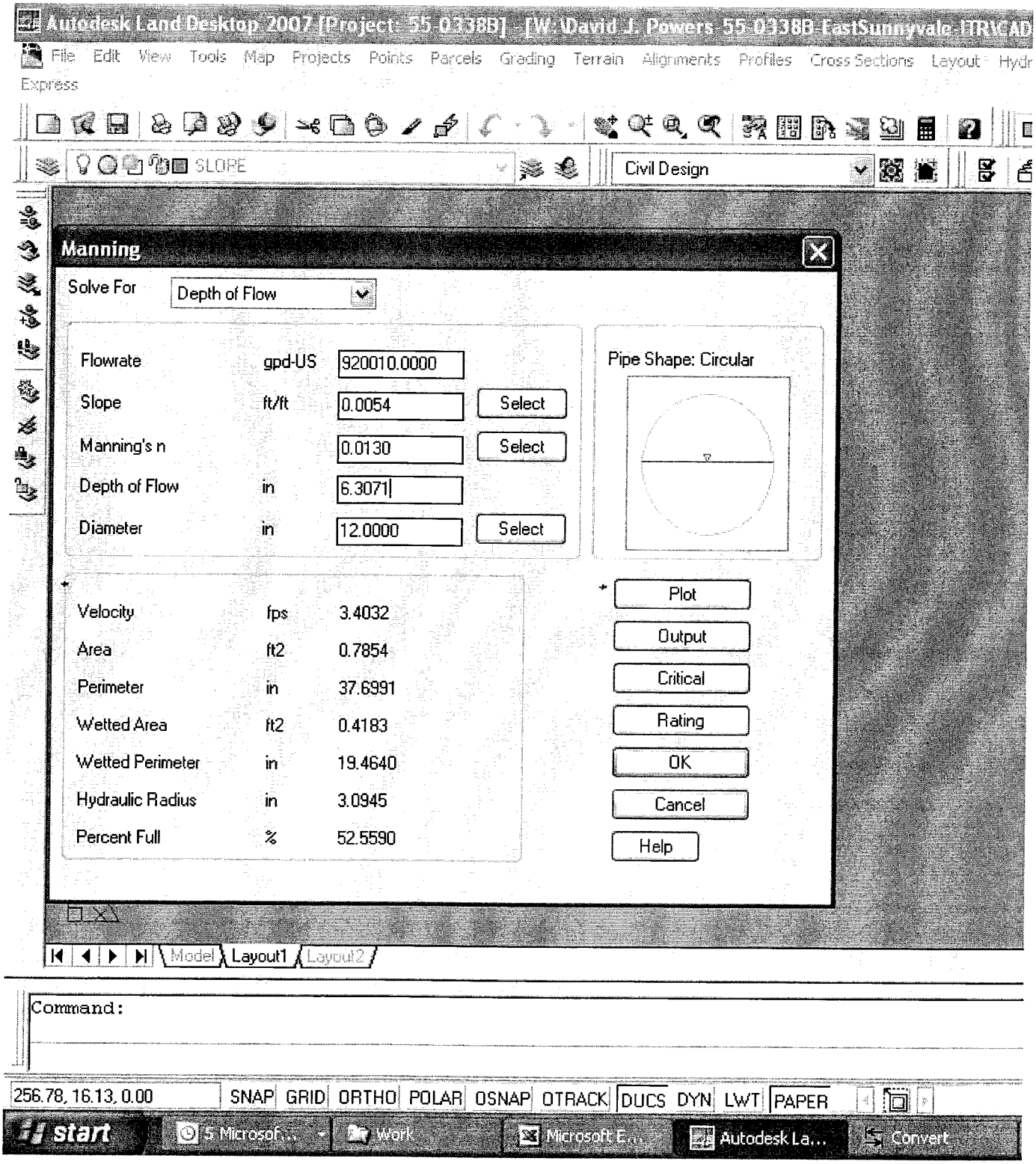
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Wetted Area ft2 0.4183
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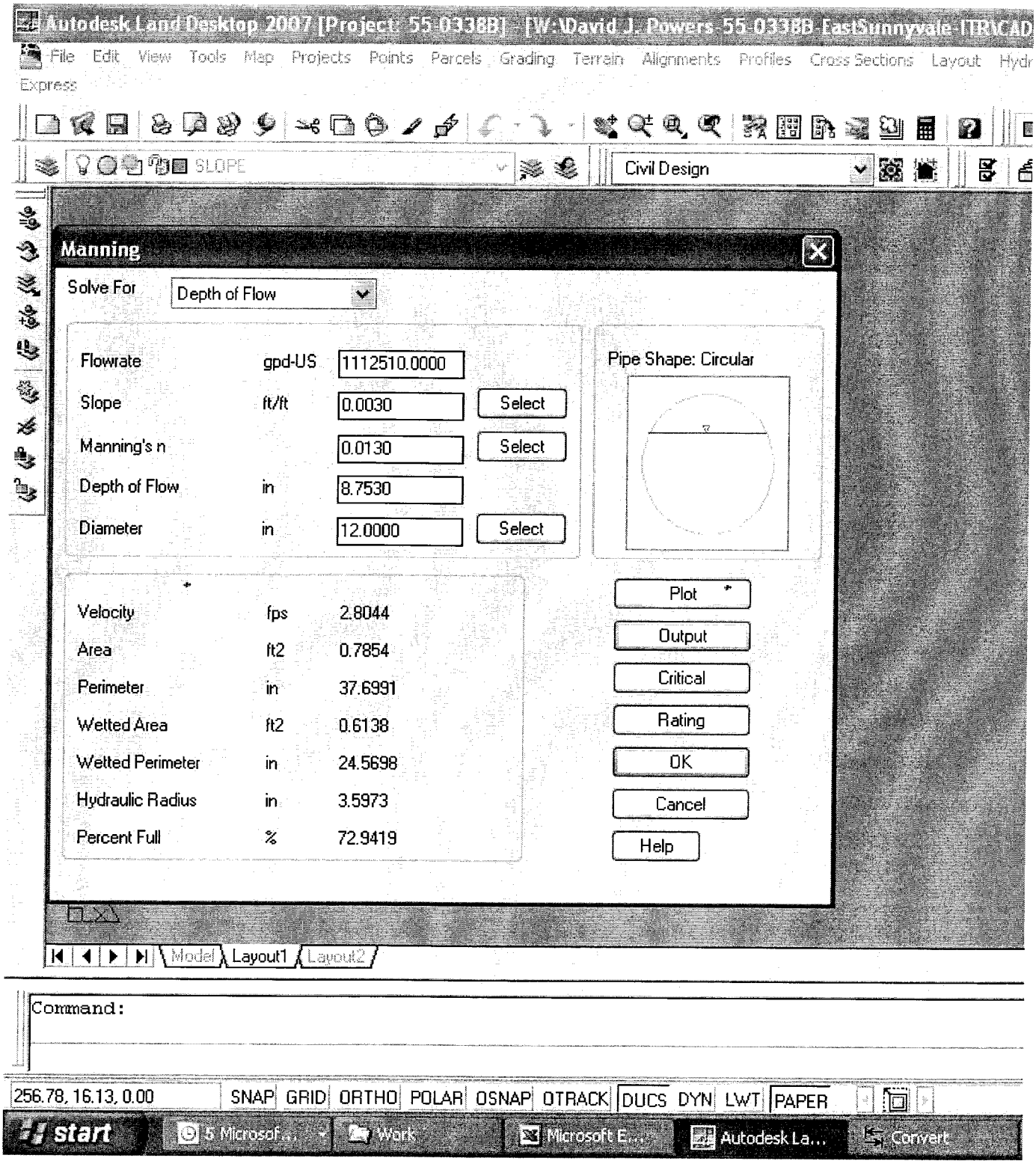
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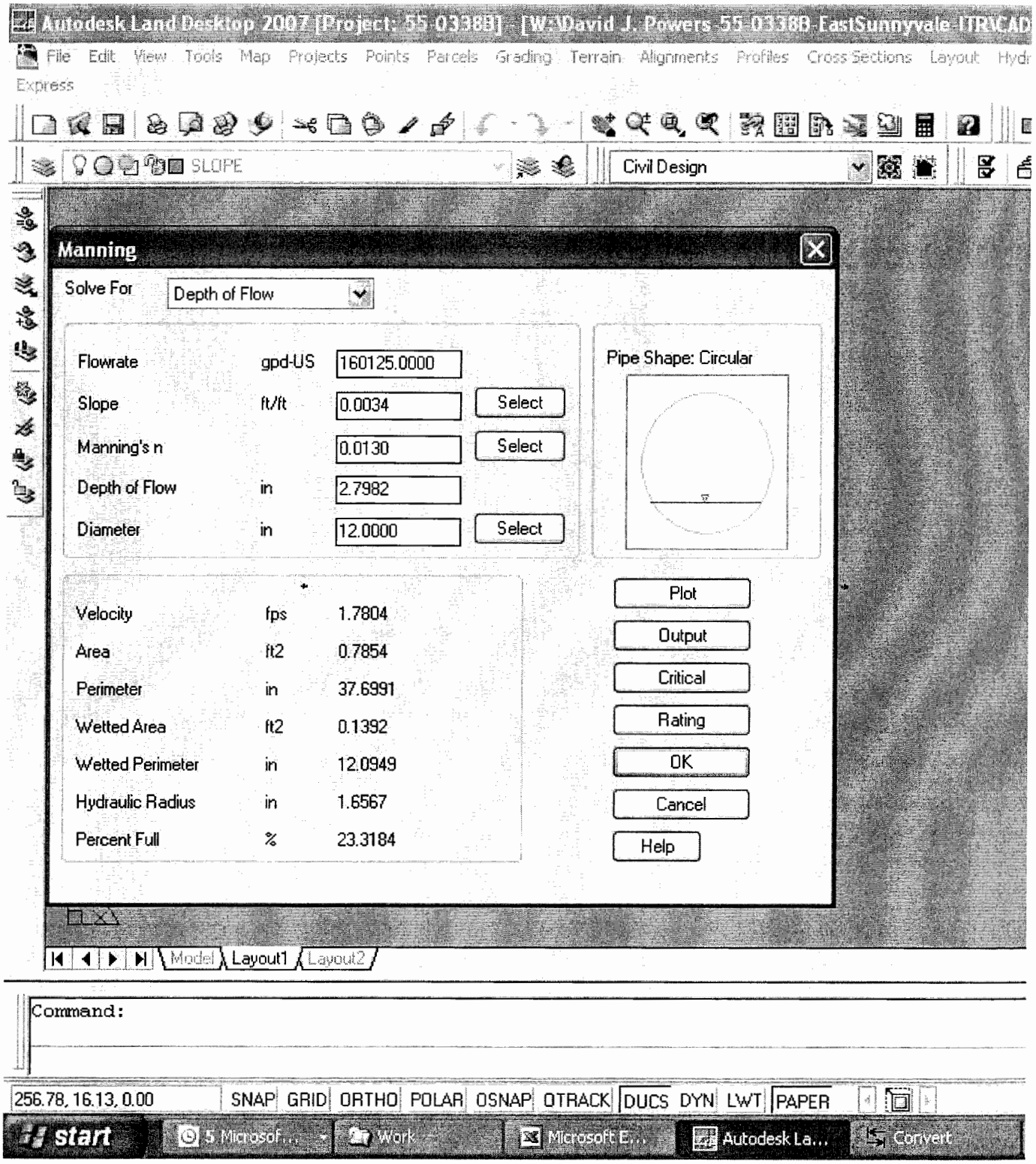
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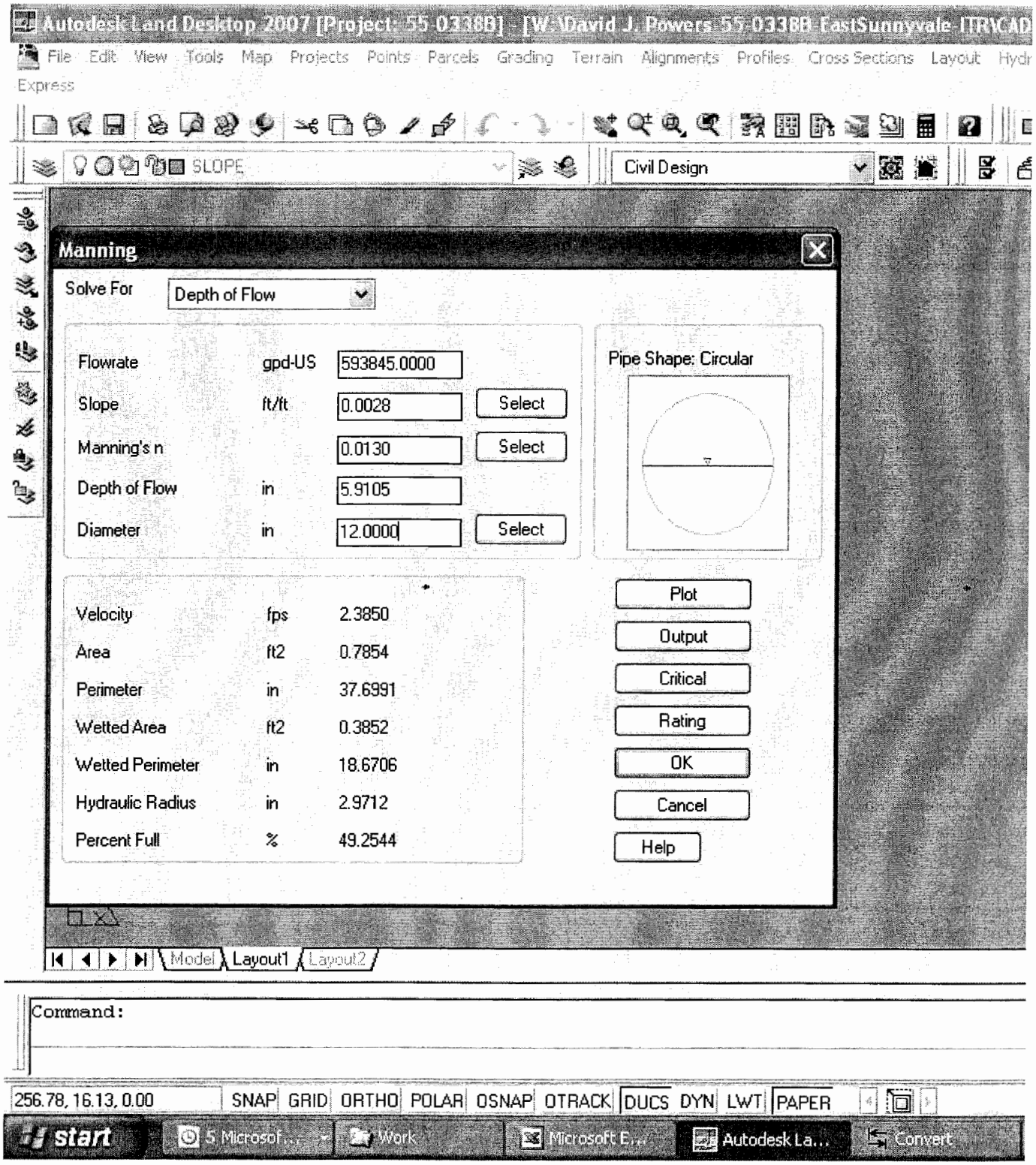
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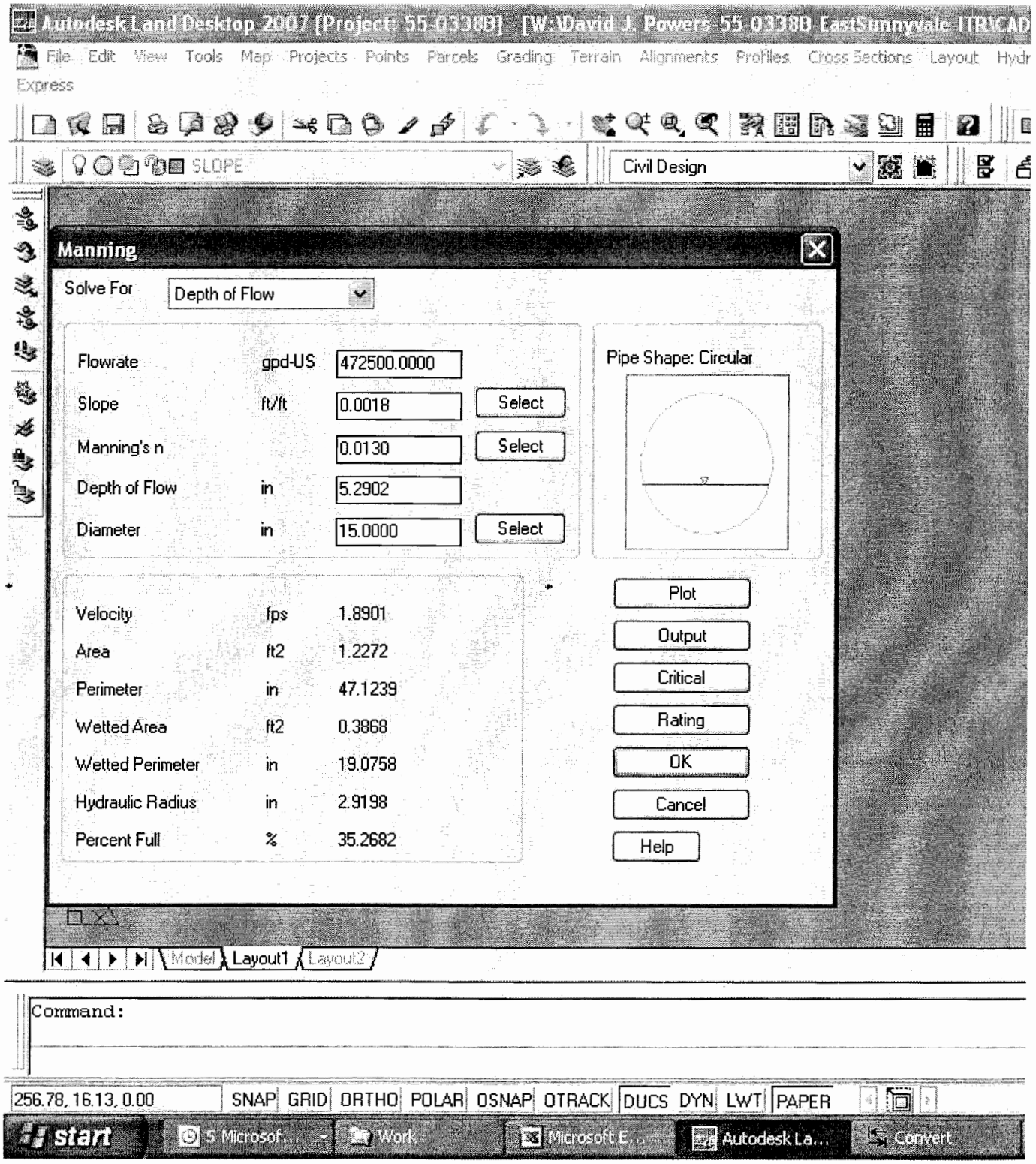
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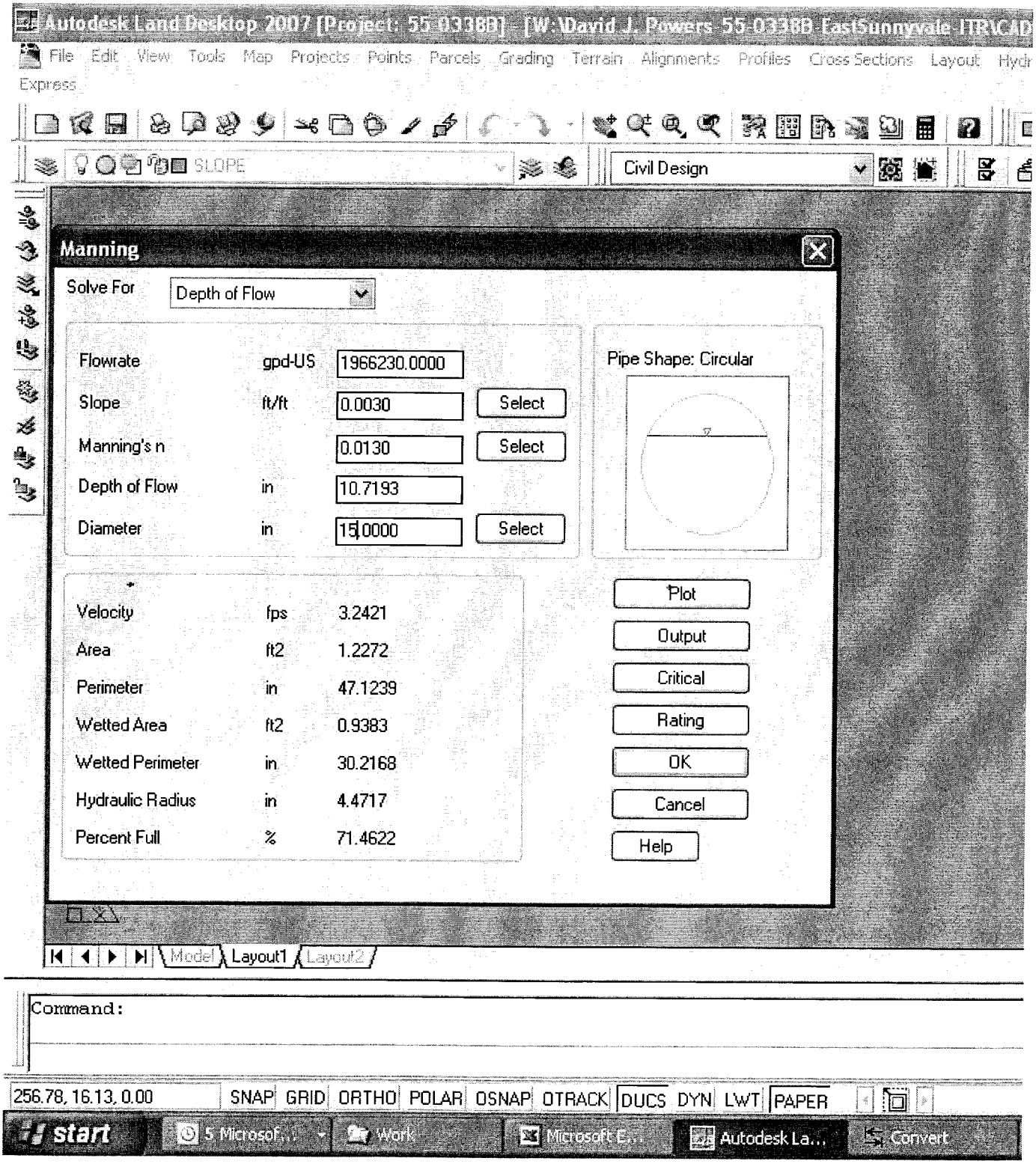
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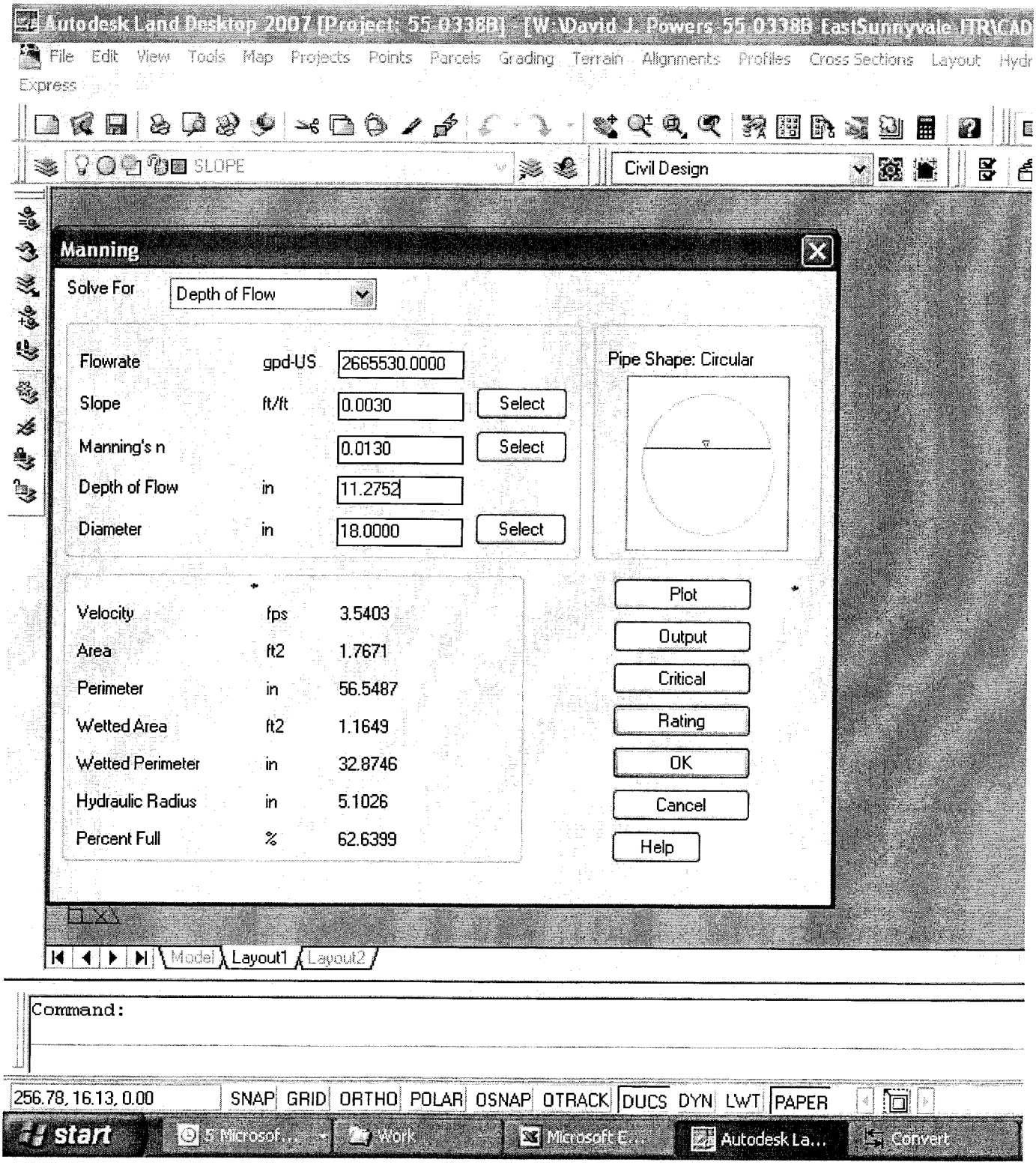
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ft2
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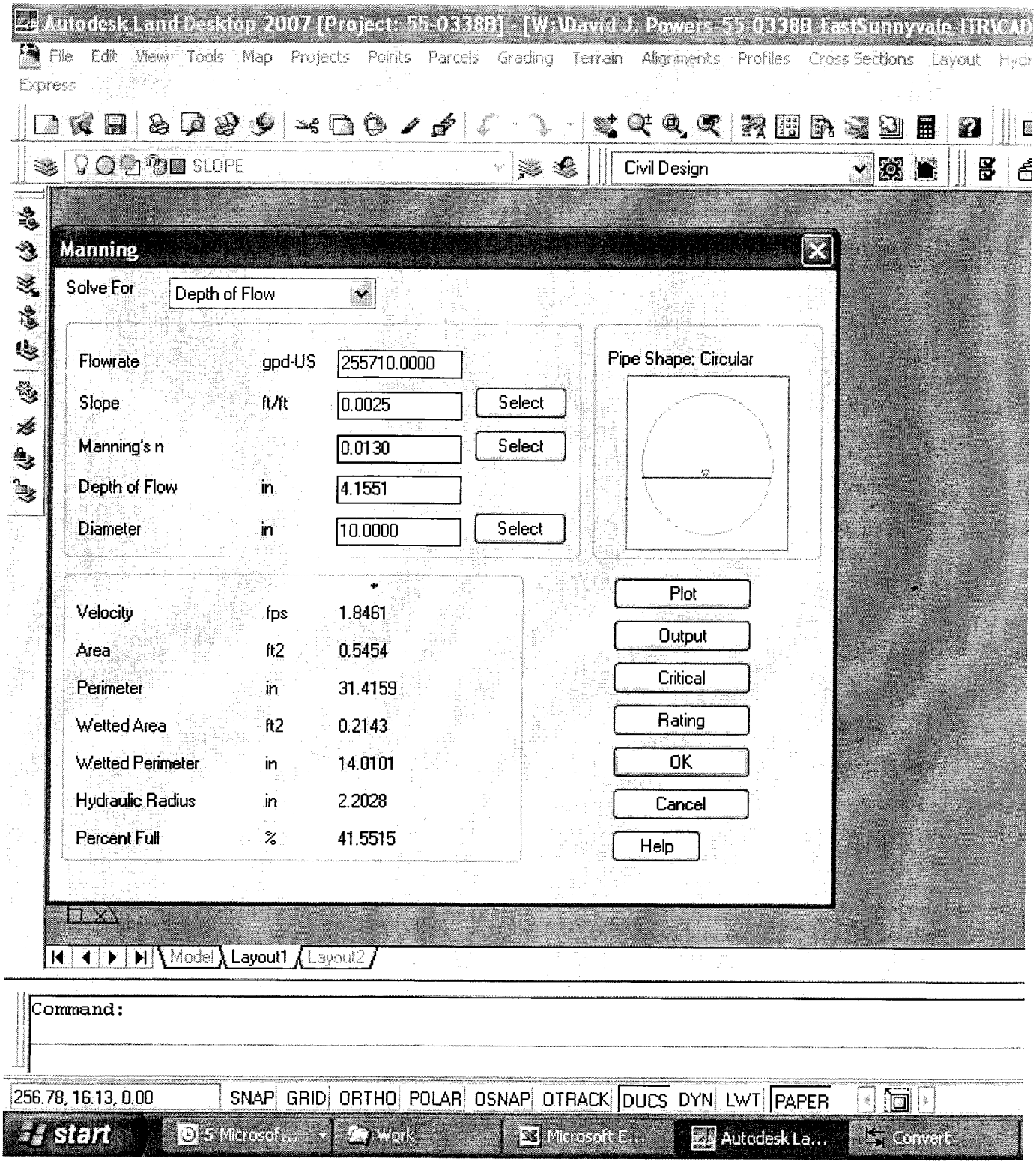
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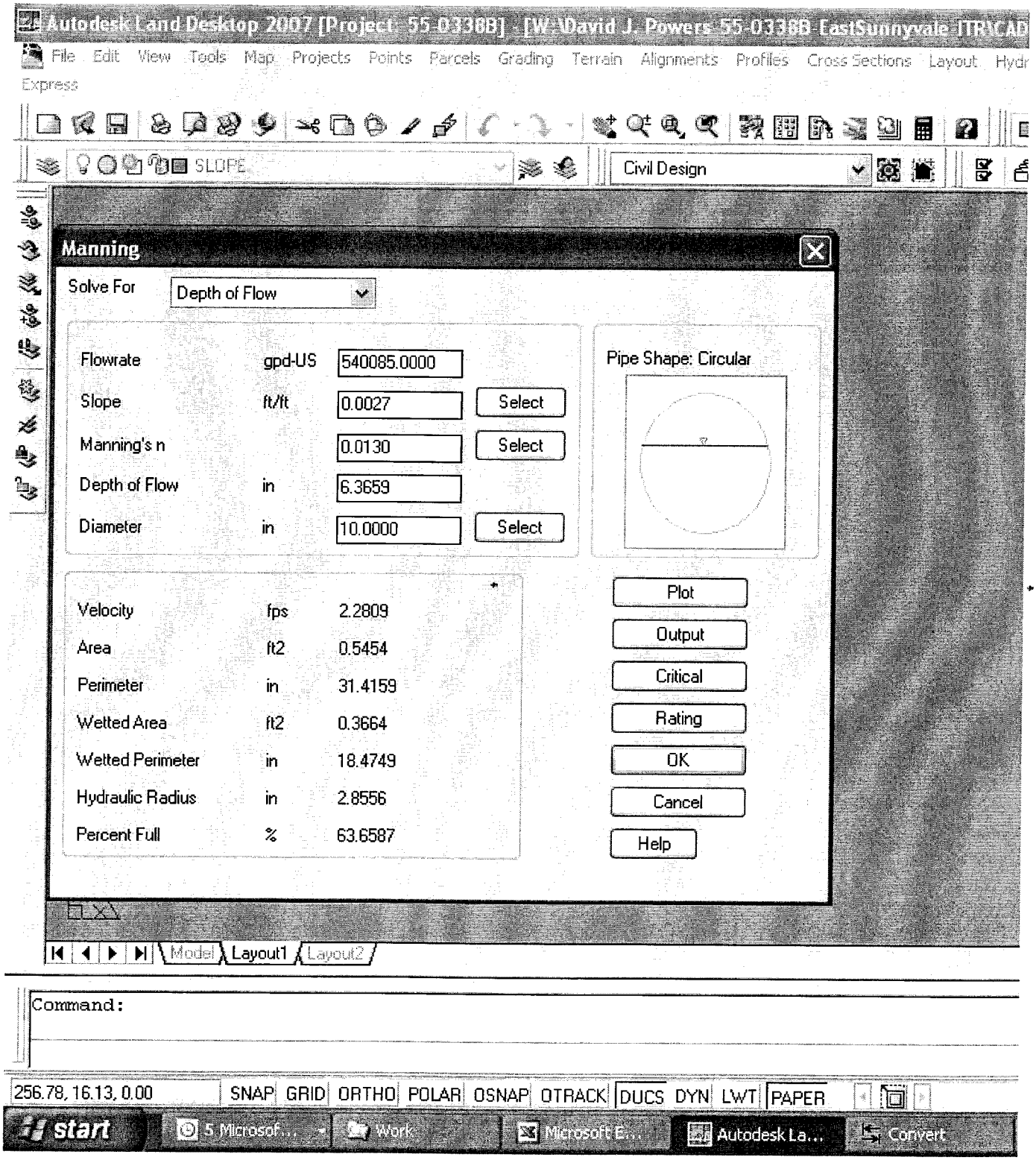
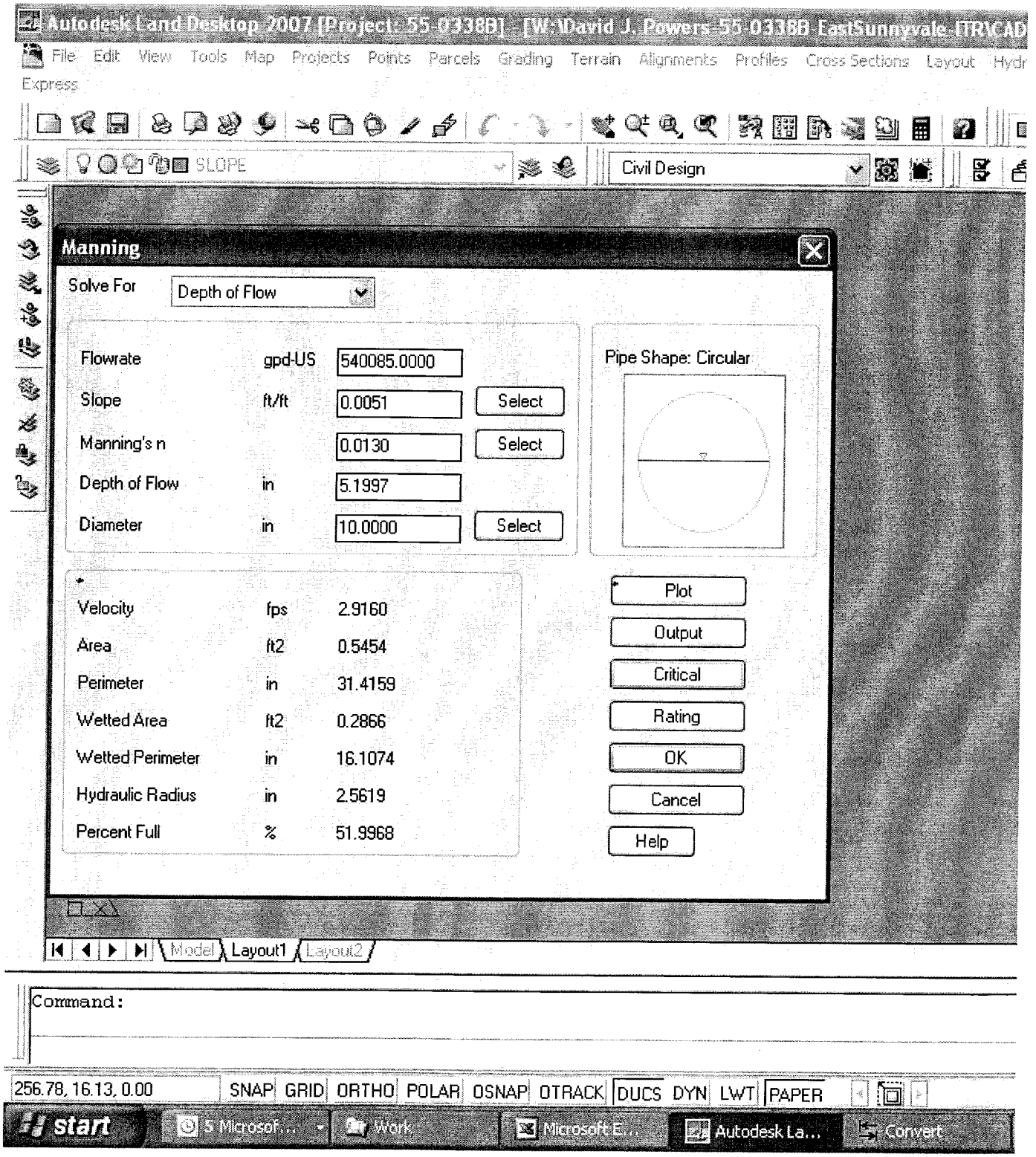
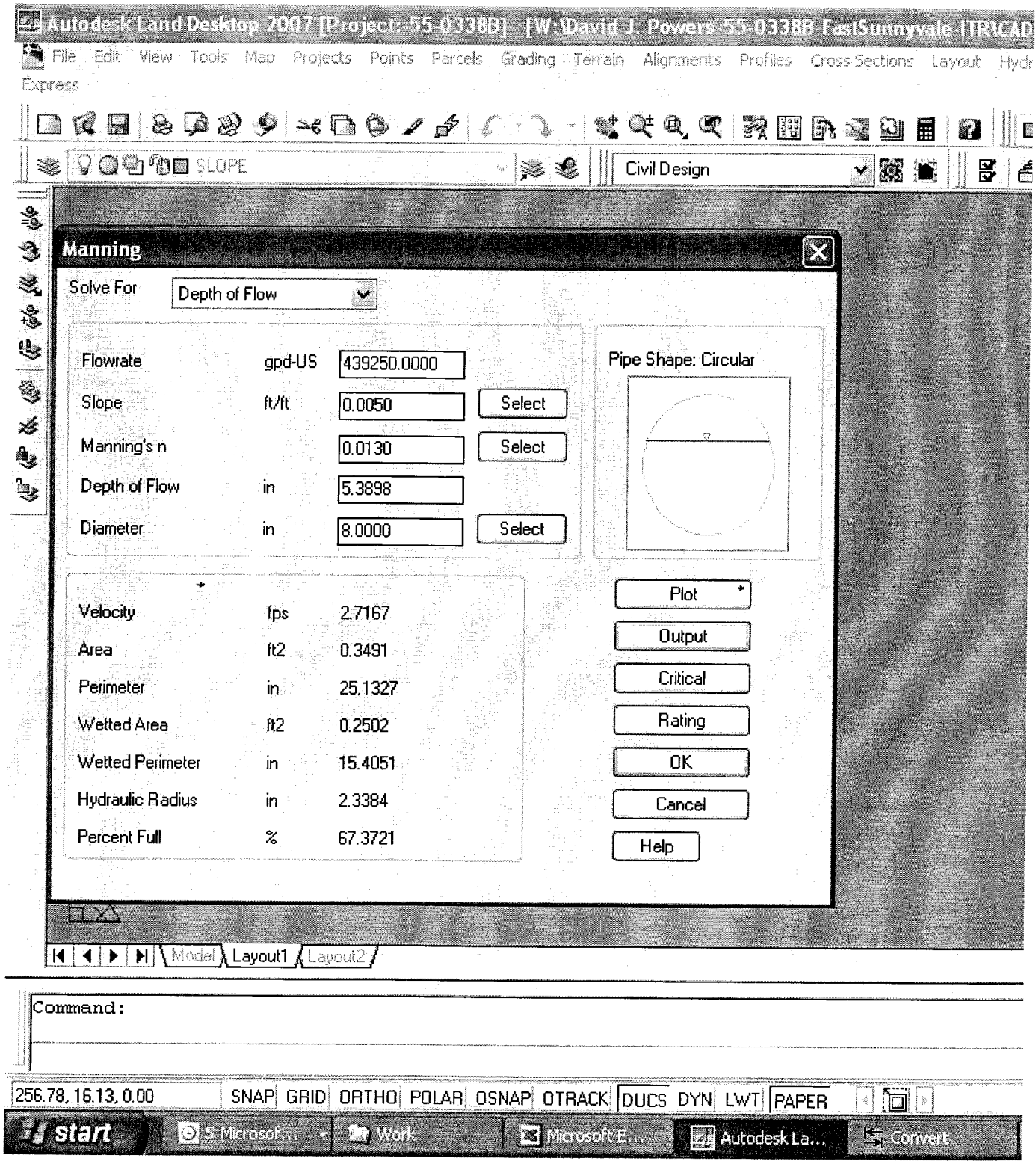
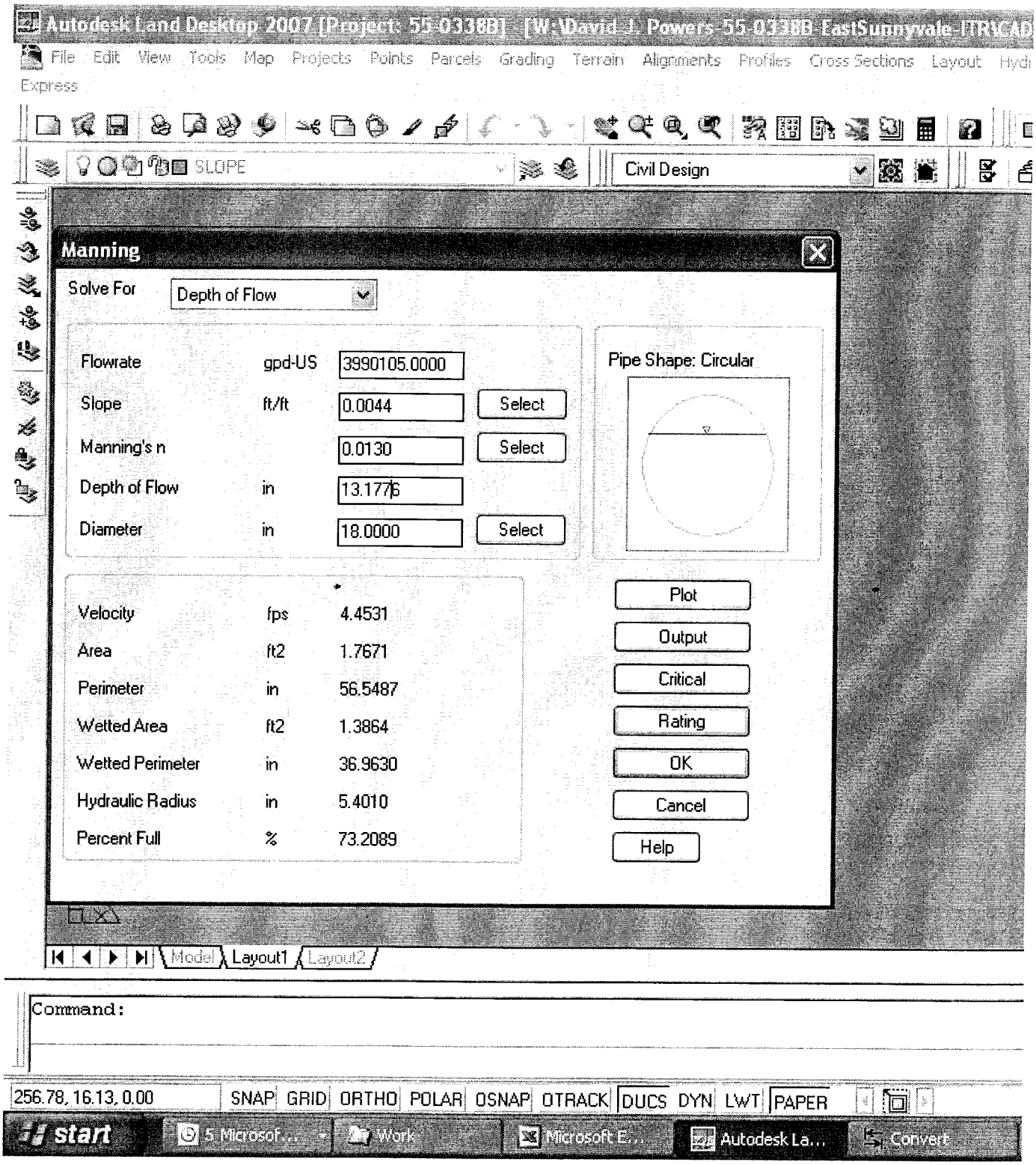
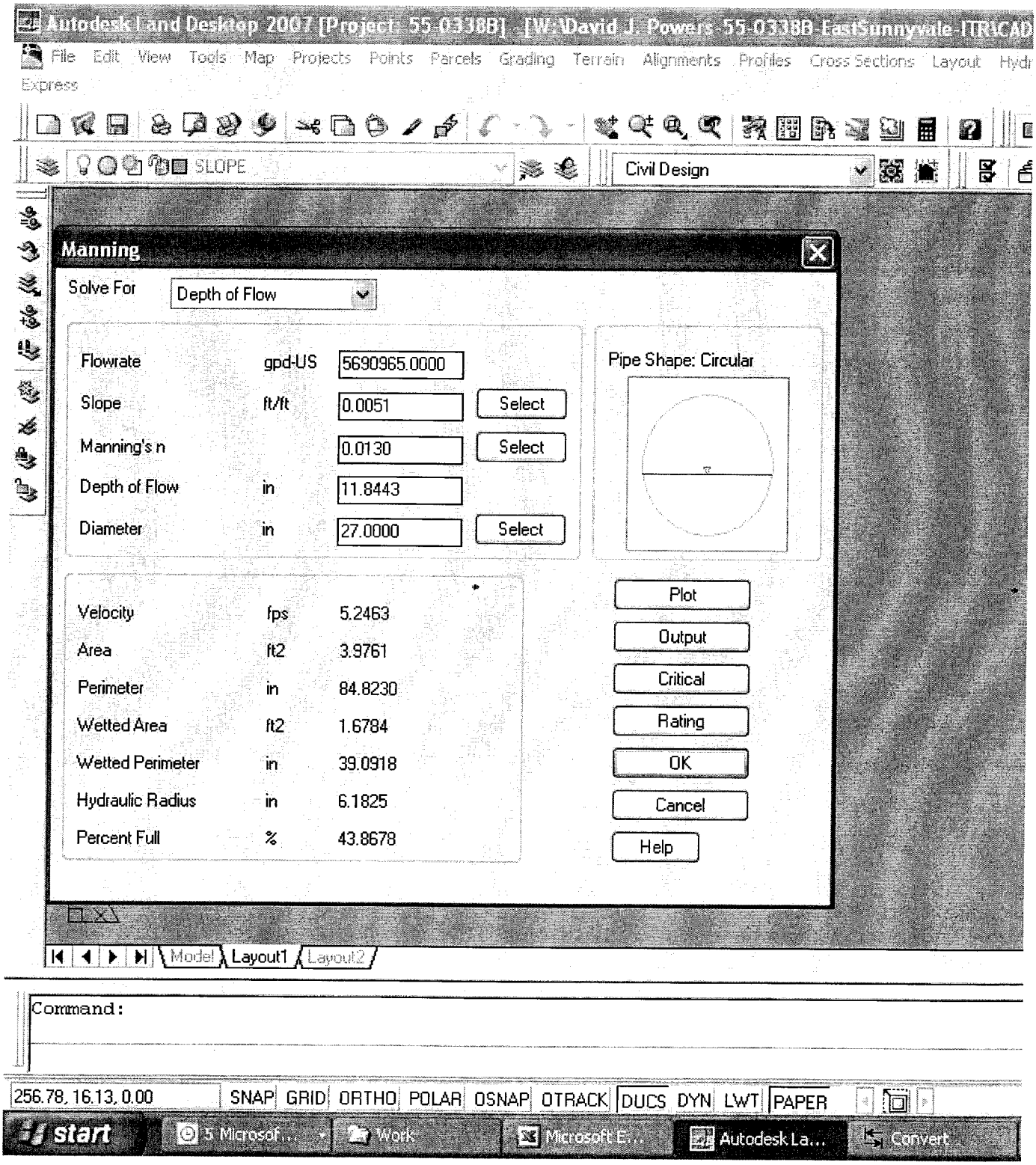
Area ft2 0.5454
Perimeter in 31.4159
Wetted Area ft2 0.2143
Wetted Perimeter in 14.0101
Hydraulic Radius in 2.2028
Percent Full % 41.5515
Plot
Output
Critical
Rating
OK
Cancel
Help
Model
Layout1
Layout2
Command:
256.78, 16.13, 0.00
SNAP GRID ORTHO POLAR OSNAP OTRACK DUCS DYN LWT PAPER
start
5 Microsof...
Work
Microsoft E...
Autodesk La...
Convert

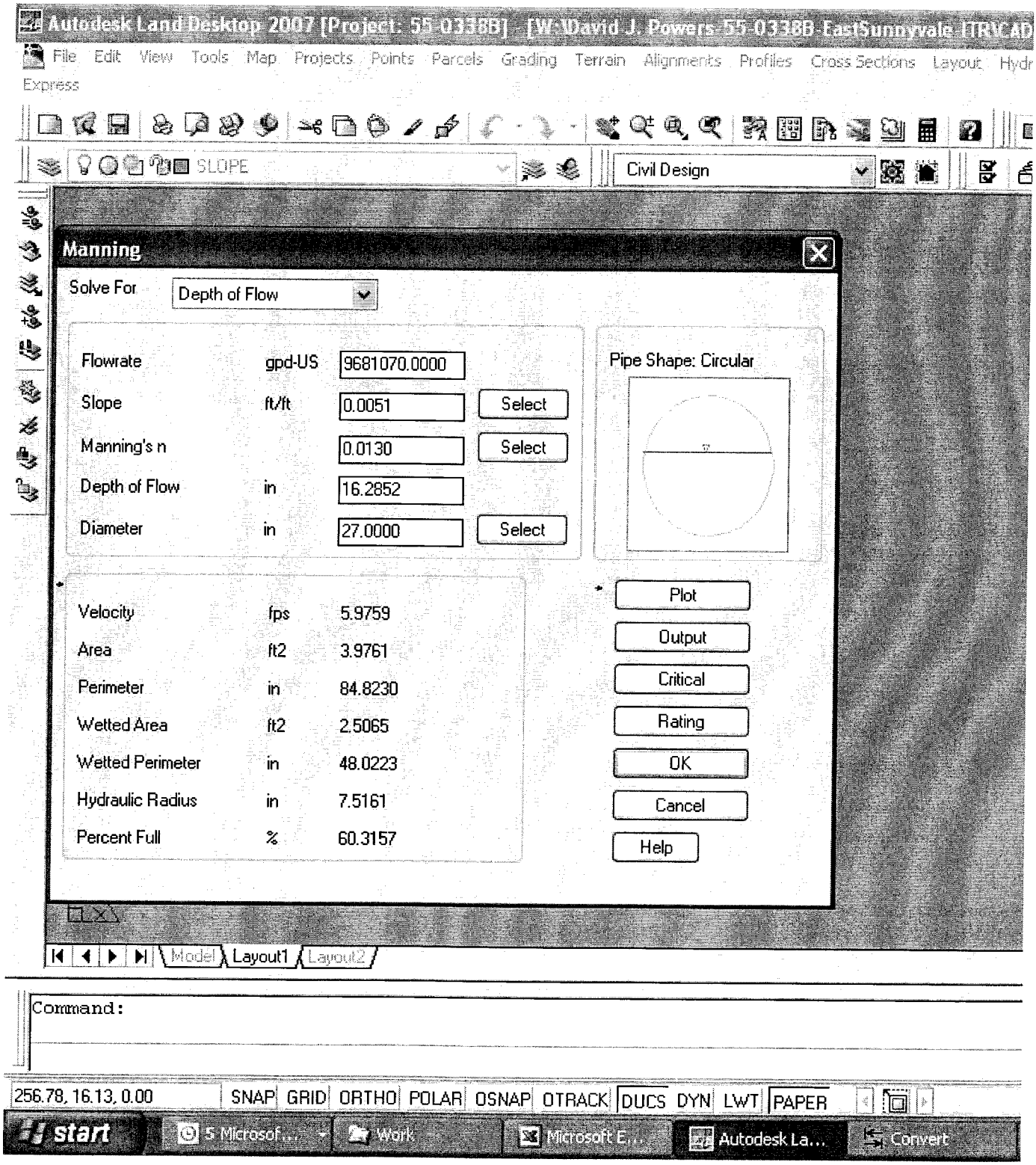

Autodesk Land Desktop 2007 [Project: 55-03368] - [W:\David J. Powers 55-03368 EastSunnyvale ITR\CAD
File Edit View Tools Map Projects Points Parcels Grading Terrain Alignments Profiles Cross Sections Layout Hydr
Express
SLOPE
Civil Design
Manning
Solve For
Depth of Flow
Flowrate gpd-US 540085.0000
Slope ft/ft 0.0027 Select
Manning's n 0.0130 Select
Depth of Flow in 6.3659
Diameter in 10.0000 Select
Pipe Shape: Circular
Velocity fps 2.2809
Area ft2 0.5454
Perimeter in 31.4159
Wetted Area ft2 0.3664
Wetted Perimeter in 18.4749
Hydraulic Radius in 2.8556
Percent Full % 63.6587
Plot
Output
Critical
Rating
OK
Cancel
Help
Model
Layout1
Layout2
Command:
256.78, 16.13, 0.00
SNAP GRID ORTHO POLAR OSNAP OTRACK DUCS DYN LWT PAPER
start
5 Microsof...
Work
Microsoft E...
Autodesk La...
Convert


Autodesk Land Desktop 2007 [Project: 55-0338B] - [W:\David J. Powers-55-0338B-EastSunnyvale-ITR\CAD
File Edit View Tools Map Projects Points Parcels Grading Terrain Alignments Profiles Cross Sections Layout Hydr
Express
SLOPE
Civil Design
Manning
Solve For
Depth of Flow
Flowrate
gpd-US
540085.0000
Slope
ft/ft
0.0051
Select
Manning's n
0.0130
Select
Depth of Flow
in
5.1997
Diameter
in
10.0000
Select
Pipe Shape: Circular
Velocity
fps
2.9160
Area
ft2
0.5454
Perimeter
in
31.4159
Wetted Area
ft2
0.2866
Wetted Perimeter
in
16.1074
Hydraulic Radius
in
2.5619
Percent Full
%
51.9968
Plot
Output
Critical
Rating
OK
Cancel
Help
Model
Layout1
Layout2
Command:
256.78, 16.13, 0.00
SNAP GRID ORTHO POLAR OSNAP OTRACK DUCS DYN LWT PAPER
start
Work
Autodesk La...
Convert


Autodesk Land Desktop 2007 [Project: 55-0338B] - [W:\David J. Powers 55-0338B EastSunnyvale-[TRYCAD
File Edit View Tools Map Projects Points Parcels Grading Terrain Alignments Profiles Cross Sections Layout Hydr
Express
SLOPE
Civil Design
Manning
Solve For
Depth of Flow
Flowrate
gpd-US
439250.0000
Slope
ft/ft
0.0050
Select
Manning's n
0.0130
Select
Depth of Flow
in
5.3898
Diameter
in
8.0000
Select
Pipe Shape: Circular
Velocity
fps
2.7167
Area
ft2
0.3491
Perimeter
in
25.1327
Wetted Area
ft2
0.2502
Wetted Perimeter
in
15.4051
Hydraulic Radius
in
2.3384
Percent Full
%
67.3721
Plot
Output
Critical
Rating
OK
Cancel
Help
Model
Layout1
Layout2
Command:
256.78, 16.13, 0.00
SNAP GRID ORTHO POLAR OSNAP OTRACK DUCS DYN LWT PAPER
start
Work
Autodesk La...
Convert


Autodesk Land Desktop 2007 [Project: 55-0338B] [W:\David J. Powers-55-0338B EastSunnyvale-ITR\CAD
File Edit View Tools Map Projects Points Parcels Grading Terrain Alignments Profiles Cross Sections Layout
Express
SLOPE
Civil Design
Manning
Solve For
Depth of Flow
Flowrate gpd-US 3990105.0000
Slope ft/ft 0.0044 Select
Manning's n 0.0130 Select
Depth of Flow in 13.1776
Diameter in 18.0000 Select
Pipe Shape: Circular
Velocity fps 4.4531
Area ft2 1.7671
Perimeter in 56.5487
Wetted Area ft2 1.3864
Wetted Perimeter in 36.9630
Hydraulic Radius in 5.4010
Percent Full % 73.2089
Plot
Output
Critical
Rating
OK
Cancel
Help
Model
Layout1
Layout2
Command:
256.78, 16.13, 0.00
SNAP GRID ORTHO POLAR OSNAP OTRACK DUCS DYN LWT PAPER
start
5 Microsof...
Work
Microsoft E...
Autodesk La...
Convert


Autodesk Land Desktop 2007 [Project: 55-0338B] - [W:\David J. Powers-55-0338B EastSunnyvale-ITR\CAD
File Edit View Tools Map Projects Points Parcels Grading Terrain Alignments Profiles Cross Sections Layout Hydr
Express
SLOPE
Civil Design
Manning
Solve For
Depth of Flow
Flowrate gpd-US 5690965.0000
Slope ft/ft 0.0051 Select
Manning's n 0.0130 Select
Depth of Flow in 11.8443
Diameter in 27.0000 Select
Pipe Shape: Circular
Velocity fps 5.2463
Area ft2 3.9761
Perimeter in 84.8230
Wetted Area ft2 1.6784
Wetted Perimeter in 39.0918
Hydraulic Radius in 6.1825
Percent Full % 43.8678
Plot
Output
Critical
Rating
OK
Cancel
Help
Model
Layout1
Layout2
Command:
256.78, 16.13, 0.00
SNAP GRID ORTHO POLAR OSNAP OTRACK DUCS DYN LWT PAPER
start
5 Microsof...
Work
Microsoft E...
Autodesk La...
Convert


Autodesk Land Desktop 2007 [Project: 55-0338B] - [W:\David J. Powers-55-0338B-EastSunnyvale-ETRV.AD
File Edit View Tools Map Projects Points Parcels Grading Terrain Alignments Profiles Cross Sections Layout Hydr
Express
SLOPE
Civil Design
Manning
Solve For
Depth of Flow
Flowrate gpd-US 9681070.0000
Slope ft/ft 0.0051 Select
Manning's n 0.0130 Select
Depth of Flow in 16.2852
Diameter in 27.0000 Select
Pipe Shape: Circular
Velocity fps 5.9759
Area ft2 3.9761
Perimeter in 84.8230
Wetted Area ft2 2.5065
Wetted Perimeter in 48.0223
Hydraulic Radius in 7.5161
Percent Full % 60.3157
Plot
Output
Critical
Rating
OK
Cancel
Help
Model
Layout1
Layout2
Command:
256.78, 16.13, 0.00
SNAP GRID ORTHO POLAR OSNAP OTRACK DUCS DYN LWT PAPER
start
5 Microsof...
Work
Microsoft E...
Autodesk La...
Convert